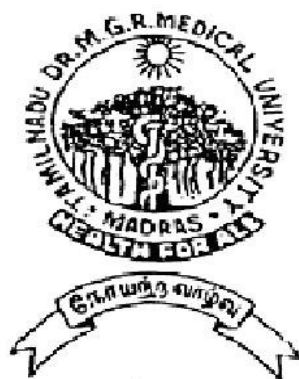


**SERUM CREATININE KINASE – MB LEVELS,
ELECTROCARDIOGRAPHIC AND ECHOCARDIOGRAPHIC FINDINGS
IN NEWBORNS WITH BIRTH ASPHYXIA**

**DISSERTATION SUBMITTED FOR THE DEGREE OF
M.D BRANCH – VII (PAEDIATRIC MEDICINE)
MARCH - 2008**



**THE TAMILNADU DR. M. G. R. MEDICAL UNIVERSITY
CHENNAI, TAMILNADU**

BONAFIDE CERTIFICATE

This is to certify that the dissertation entitled “**SERUM CREATININE KINASE – MB LEVELS, ELECTROCARDIOGRAPHIC AND ECHOCARDIOGRAPHIC FINDINGS IN NEWBORNS WITH BIRTH ASPHYXIA**” is bonafide record work done by **Dr. V.ANURADHA** under my direct supervision and guidance, submitted to the Tamil Nadu Dr. M.G.R. Medical University in partial fulfillment of University regulation for MD, Branch VII –PAEDIATRIC MEDICINE.

PROF. DR.M.L.VASANTHAKUMARI. M.D., D.C.H.,
Prof. & Head of the Department,
Institute of Child Health and Research Centre,
Madurai Medical College,
Madurai-20.

DECLARATION

I, **Dr.V. ANURADHA**, solemnly declare that the dissertation titled **“SERUM CREATININE KINASE – MB LEVELS, ELECTROCARDIO GRAPHIC AND ECHOCARDIOGRAPHIC FINDINGS IN NEWBORNS WITH BIRTH ASPHYXIA”** has been prepared by me. I also declare that this bonafide work or a part of this work was not submitted by me or any other for any award, degree, diploma to any other University board either in India or abroad.

This is submitted to The Tamilnadu Dr. M. G. R. Medical University, Chennai in partial fulfillment of the rules and regulation for the award of .M.D degree Branch – VII (Paediatric Medicine) to be held in March 2008.

Place : Madurai

Dr. V. ANURADHA

Date :

ACKNOWLEDGEMENT

I offer my sincere thanks to my Professor, Professor Dr. M.L.Vasanthakumari, Head of the Department & Unit Chief, Institute of Child Health and Research Centre, Madurai Medical College for motivating, guiding and encouraging me in conducting this study.

I owe my thanks to my Professors, Prof. Dr D. Meikandan, Prof Dr. P. Amudha Rajeswari, Prof Dr. S. Rajasekaran, Prof .Dr. G. Mathevan, Prof. Dr. Chitra Ayyappan, Dr. Mathiarasan, Dr.S. Nataraja Rathinam, Dr. S. Venkateswaran, Dr. S. Balasankar, Dr. S. Balasubramanian, Dr. T. Nagarajan, Dr. S. Sampath, Dr. Kulandaivel, Dr. E. Sivakumar, Dr. Kannan for their critical review and suggestions during the dissertation meetings.

I offer my special thanks to my Asst. Professors Dr. S. Shanmugasundaram and Dr. M.S. Rajarajeswaran for their invaluable guidance, help and suggestions throughout my study.

I also express my thanks to Prof. Dr. G. Murugan. MD.,DM (Cardiology), Professor of Cardiology for his guidance. I thank the Professor of Biochemistry for carefully analyzing and interpreting my samples.

I am thankful to the Dean, Madurai Medical College and Government Rajaji Hospital who has been kind enough to permit me to use the hospital materials.

I thank the Staff Nurses in the Newborn ward for their co-operation with me during my study. I also thank the ECG technicians for their friendly co-operation in taking ECG for the newborns.

I will fail in my duty if I do not thank the newborns and their mothers who have co-operated with me in undertaking this venture.

CONTENTS

SL. NO.	TITLE	PAGE NO.
1.	INTRODUCTION	1
2.	REVIEW OF LITERATURE	13
3.	AIMS AND OBJECTIVES	19
4.	MATERIALS AND METHODS	20
5.	OBSERVATION AND RESULTS	23
6.	DISCUSSION	44
7.	CONCLUSIONS	52
8.	LIMITATIONS OF THE STUDY	54
9.	RECOMMENDATIONS	55
	ANNEXURES	
	BIBLIOGRAPHY	
	LIST OF TABLES	
	LIST OF FIGURES	
	PROFORMA	
	MASTER CHART	
	ABBREVIATIONS	

INTRODUCTION

Birth asphyxia in the newborn is a major cause of neonatal mortality and long term morbidity. The incidence of birth asphyxia is 1.0 to 1.5% of live births.¹ Cardiac abnormalities in birth asphyxia were first recognized in 1970s.²

These include

- i) Transient tricuspid regurgitation which is the commonest cause of a systolic murmur in the newborn and tends to disappear without any treatment unless it is associated with transient myocardial ischemia or persistent pulmonary hypertension of the newborn
- ii) Transient mitral regurgitation which is much less common and is often a part of transient myocardial ischemia
- iii) Transient myocardial ischemia of the newborn
- iv) Persistent pulmonary hypertension of the newborn.

CK-MB levels rise with myocardial ischemia.² ECG is very important for the diagnosis of transient myocardial ischemia, and shows changes ranging from T wave inversion in one lead to a classical segmental infarction pattern with abnormal q waves. Echocardiogram shows impaired left ventricular function, mitral or tricuspid regurgitation and at times, wall motion abnormalities of the left ventricle. Ejection fraction is often depressed and is a useful marker of severity and prognosis. Treatment includes fluid restriction, Oxygen, inotropic support, diuretic and ventilatory assistance if required.

Cardiac abnormalities in asphyxiated newborns are often underdiagnosed and require a high index of suspicion.² CK-MB, Electrocardiogram and Echocardiogram help in early recognition and hence better management of these cases.

BIRTH ASPHYXIA

Definition :

National Neonatology Forum of India³ has suggested that birth asphyxia should be diagnosed when “Baby has gasping and inadequate breathing or no breathing at 1 minute”.

Birth asphyxia is an insult to the fetus or newborn due to lack of oxygen and or a lack of perfusion to various organs of sufficient magnitude and duration to produce more than fleeting functional and / or biochemical changes. It is associated with tissue lactic acidosis.

Incidence :

The incidence of perinatal asphyxia is 1 to 1.5% of live births¹ in most centres. It is inversely related to the gestational age and birth weight. Its incidence is higher in term infants of diabetic or toxemic mothers. Intrauterine growth retardation and breech presentation are associated with an increased incidence of birth asphyxia. Post mature infants are also at risk.

Etiology of Asphyxia :

90% of asphyxia occurs during antepartum or intrapartum periods.¹ The remainder are postpartum, usually due to pulmonary, cardiovascular or neurological abnormalities.

During normal labour,

- i) Some degree of cord compression results in reduced blood flow to the placenta and hence decreased oxygen delivery to the fetus.
- ii) Maternal dehydration and maternal alkalosis from hyperventilation reduces placental blood flow.
- iii) Maternal hypoventilation decreases maternal and fetal O₂ saturation.

These normal events cause most babies to be born with little O₂ reserve. In addition to these factors, any of the following factors like maternal hypertension, maternal vascular disease, maternal diabetes, maternal drug use, maternal hypoxia from pulmonary, cardiac or neurologic disease, maternal hypotension, maternal infection, placental infarction or fibrosis, placental abruption, cord prolapse, cord compression, true knot, abnormalities of umbilical vessels, fetal anemia, fetal or placental hydrops, intrauterine growth retardation and post maturity when present exacerbate birth asphyxia.

After birth, hypoxia may result from

- 1) Anemia severe enough to lower the oxygen content of the blood to a critical level due to severe hemorrhage or hemolytic disease.

- 2) Shock severe enough to interfere with the transport of oxygen to vital organs from adrenal hemorrhage, intraventricular hemorrhage, overwhelming infection or massive blood loss.
- 3) A deficit in arterial oxygen saturation resulting from failure to breathe adequately postnatally due to a neuronal defect, necrosis or injury.
- 4) Failure of oxygenation of an adequate amount of blood resulting from severe forms of cyanotic congenital heart disease or deficient pulmonary function.

Pathophysiology : ¹

In the presence of a hypoxic ischemic challenge to the fetus, reflexes are initiated, causing shunting of blood to the brain, heart and adrenals and away from the lungs, gut, liver, kidneys, spleen, bone, skeletal muscle and skin ('diving reflex'). In mild hypoxia there is a decreased heart rate, slight increase in blood pressure to maintain cerebral perfusion, increased central venous pressure and little change in cardiac output. As asphyxia progresses, with severe hypoxia and acidosis, there is a decreased heart rate, decreased cardiac output, and initially increased then falling BP as oxidative phosphorylation fails and energy reserves become depleted.

Pathology:

The pathology of hypoxia and ischemia is dependant upon the affected organ and the severity of the insult. Early congestion, fluid leak from increased capillary permeability and endothelial cell swelling may then lead to signs of coagulation and cell death. Congestion and petechial hemorrhages are seen in the pericardium, pleura, thymus, heart, adrenals and meninges. Prolonged intrauterine hypoxia may result in periventricular leukomalacia and pulmonary arteriolar smooth muscle hyperplasia, which predisposes the infant to pulmonary hypertension, respiratory distress, produces gasping and aminotic contents (meconium, squames, lanugo hair) are aspirated into the trachea and lungs.

The combination of chronic fetal hypoxia and acute hypoxic ischemic injury after birth results in gestational age specific neuropathology. Term infants show neuronal necrosis of the cortex (later cortical atrophy) and parasagittal ischemic injury. Preterm infants show periventricular leukomalacia (later spastic diplegia), status marmoratus of the basal ganglia and intraventricular hemorrhage. Term, more often than preterm infants demonstrate focal or multifocal cortical infarcts that produce focal seizure and hemiplegia. Increased intracranial pressure occurs in some infants who have severe hypoxic-ischemic encephalopathy. Excitatory amino acids may play an important role in the pathogenesis of asphyxial brain injury.

SYSTEMIC EFFECTS OF BIRTH ASPHYXIA :

SYSTEM	EFFECT
Heart	Transient myocardial ischemia, decreased left ventricular contractions, persistent pulmonary hypertension, tricuspid regurgitation with right to left shunt at atrial level, right ventricular or left ventricular dysfunction.
Brain	Hypoxic ischemic encephalopathy, infarction, cerebral edema, intracranial hemorrhage, seizures, hypotonia, hypertonia.
Lungs	Pulmonary hemorrhage, pneumothorax, meconium aspiration syndrome, increased pulmonary vascular resistance, shock lungs.
Kidneys	Acute tubular necrosis, cortical necrosis, renal vein thrombosis, renal failure, hematuria
Adrenal	Adrenal hemorrhage
Gastro intestinal	Perforation, ulceration, necrosis
Metabolic	Inappropriate secretion of antidiuretic hormone, hyponatremia, hypoglycemia, hypocalcemia, myoglobinuria
Integument	Subcutaneous fat necrosis
Hematologic	Disseminated intravascular coagulation, sepsis, hyperbilirubinemia

Sarnat & Sarnat Stages¹ of Hypoxic Ischemic Encephalopathy

Stage	Stage1 (Mild)	Stage 2 (Moderate)	Stage 3 (Severe)
Level of consciousness	Hyper alert, irritable	lethargic or obtunded	stuporous, comatose
Neuromuscular control	Uninhibited, overactive	Diminished spontaneous	Diminished or absent spontaneous

		movement	movement
Muscle tone	Normal	Mild hypotonia	Flaccid
Posture	Mild distal flexion	Strong distal flexion	Intermittent decerebration
Stretch Reflexes	Overactive	Overactive, disinhibited	Decreased or absent
Segmental myoclonus	Present or absent	Present	Absent
Complex reflex	Normal	Suppressed	Absent
Suck	Weak	Weak or Absent	Absent
Moro	Strong, Low threshold	Weak, incomplete high threshold	Absent
Oculovestibular	Normal	Overactive	Weak or Absent
Tonic Neck reflex	Slight	Strong	Absent
Autonomic function	Generalised sympathetic	Generalised parasympathetic	Both systems depressed
Pupils	Mydriasis	Miosis	Mid position
Respiration	Spontaneous	Spontaneous occasional apnoea	Periodic, apnoea.
Heart Rate	Tachycardia	Bradycardia	Variable
Bronchial and Salivary secretion	Sparse	Profuse	Variable
GI motility	Normal or decreased	Diarrhoea	Variable
Seizures	None	Common	Uncommon
EEG	Normal	Early : Generalised low voltage slowing Late : Periodic pattern	Early : Periodic Late: Isopotential
Duration of symptoms	< 24 hrs	2 to 14 days	Hours to week
Outcome	About 100% normal	80% Normal	50% die, remainder with severe sequelae

CARDIOVASCULAR EFFECTS OF BIRTH ASPHYXIA

Transient myocardial ischemia :

Infants with perinatal asphyxia have transient myocardial ischemia. ECG shows ST depression in midprecordium and T wave inversion in left precordium. Serum Creatine Kinase MB isoenzyme fraction is more than 5-10% of the total creatine kinase and represents myocardial damage. Echocardiogram shows decreased left ventricular contractions, especially of the posterior wall. Left ventricular end –diastolic pressures are elevated.

Tricuspid valve disease :

An abnormally functioning but normal tricuspid valve is a common finding in the newborn with asphyxial cardiomyopathy. This causes tricuspid regurgitation with right ventricular myocardial disease. Tricuspid regurgitation of this type tends to regress as the underlying problem resolves.

Mitral valve disease :

Asphyxial cardiomyopathy with left ventricular dilated cardiomyopathy causes mitral regurgitation. This tends to regress as the underlying problem resolves. Left ventricular dysfunction is rare (10%) when compared to right ventricular dysfunction (30%).

Persistent fetal circulation :

Persistent fetal circulating pattern of right to left shunting through the patent ductus arteriosus and foramen ovale after birth is due to an excessively high pulmonary vascular resistance. This high pulmonary vascular resistance is due to pulmonary smooth muscle hyperplasia. Chronic fetal hypoxia causes increased pulmonary artery medial muscle thickness and extension of smooth muscle layer into the usually non-muscular, more peripheral pulmonary arterioles.

Dilated Cardiomyopathy :

It is characterized by cardiac dilatation, diminished cardiac contractility and congestive cardiac failure. Ventricular dilatation and tachycardia occur in an attempt to maintain cardiac output despite diminished systolic shortening fraction.

Pulmonary edema may develop and cardiac output is often diminished.

Hypoxia, ischemia, often with pulmonary hypertension, lactic acidemia, hypercarbia, hypothermia, hypocalcemia, anemia or polycythemia, may contribute to myocardial dysfunction. Treatment consists of correction of the co-existent metabolic abnormalities, supporting the myocardium with intravenous fluids and inotropic agents (eg. dopamine, dobutamine, epinephrine and amrinone), using antidysrhythmics as needed and judiciously providing fluids to maintain cardiac output while minimizing edema.

Congestive heart failure :

The cause of congestive heart failure in an asphyxiated newborn is primary myocardial dysfunction due to transient myocardial ischemia. Post asphyxial cerebral dysfunction causes alveolar hypoventilation which causes asphyxia. The neonate with congestive cardiac failure usually presents with tachypnoea, tachycardia, hepatomegaly, diaphoresis, poor perfusion, feeding difficulties, edema, growth failure and cardio vascular collapse.

Cardiac dysrhythmias :

Ventricular fibrillation, tachycardia, sinus node arrest or extreme bradycardia are usually associated with severe asphyxia.

REVIEW OF LITERATURE

Asphyxia neonatorum is a serious postnatal complication and is one of the commonest causes of neonatal morbidity and mortality. Myocardial ischemia with unobstructed coronary arteries in a newborn is gaining wider recognition (Finley et al – 1979⁴; SR Daga et al 1983)⁵. Cases with asphyxia have primary myocardial dysfunction due to this transient myocardial ischemia. Anoxia affects cardiac function and hypotension so caused may reduce the cardiac output leading to the features of “myocardial infarction” due to inadequate coronary perfusion and arrhythmias in some. Richart et al⁶ have used the term myocardial infarction in their article – Myocardial infarction in prenatal period – Journal of paediatrics – 1959; 55; 706-712.

Infants with birth asphyxia have transient myocardial ischemia. Serum Creatine Kinase – MB isoenzyme fraction is more than 5-10% and represents myocardial damage.

ECG recording is a good parameter for the diagnosis of ischemic damage of the neonatal heart. ECG tracings correlated well with the myocardial histology (Dische MR. et al⁷ – Effects of hypoxia on the infantile heart, 1977). Similarly the electrocardiographic changes correlated well with the thallium myocardial ischemia demonstrated by thallium imaging, (Finley et al⁴, Transient myocardial ischemia demonstrated by thallium imaging, 1979). The criteria for electrocardiographic diagnosis of ischemic damage have been laid down taking the following into consideration – flat or inverted T waves, ST segment changes, abnormal Q waves (Jedeikin et al).⁸

Echocardiogram shows impaired left ventricular function, mitral and / or tricuspid regurgitation, and at times, wall motion abnormalities of left ventricle. Ejection fraction is often depressed and is a useful marker of severity and prognosis. (Ranjit MS², Cardiac abnormalities in birth asphyxia, IJP, 2000, March; 67).

Barberi et al¹⁰ in Myocardial ischemia in neonates with prenatal asphyxia, evaluated cardiac involvement in neonates with respiratory distress, ECG and echocardiographic recordings well performed, and cardiac enzymes determined. Three groups were studied; 22 healthy new born infants (group I) with 5 min Apgar scores > 9 and pH > 7.3; 15 neonates with moderate respiratory distress (group II) which had Apgar scores ranging between 7 and 9, and pH between 7.2 and 7.3; and 13 neonates with severe asphyxia, Apgar scores < 7 and pH < 7.2 (group III). The ECGs were evaluated according to the 4- grade classification proposed by Jedeikin et al.⁸ Echocardiogram was done for all the patients. Serum CK-MB was determined. All of groups I & II survived, but 5 out of 13 in group III died, grade 3 or 4 ECG changes were observed only in group III patients, while all group II and 3 of group I showed grade 2 ECG changes. CK-MB, CK-MB/CK ratio were increased in group III and group II. Severely asphyxiated infants reflect relevant ischemic electrocardiographic changes, depressed left ventricular function and marked cardiac enzyme increase.

According to Ranjit MS², in cardiac abnormalities in birth asphyxia, ECG is very important for diagnosis of TMI, and may show changes ranging from T wave inversion

in one lead to a classical segmental infarction pattern with abnormal q waves. CK-MB may rise and echo shows impaired left ventricular function, mitral and or tricuspid regurgitation, and at times wall motion abnormalities of left ventricle. Ejection fraction is often depressed and is a useful marker of severity and prognosis. Treatment requires fluid restriction, inotropic support, diuretics and ventilatory assistance if required.

Turner Gomes et al¹¹ studied the persistence of atrio ventricular valve regurgitation (AVVR) and ECG abnormalities following transient myocardial ischemia of the new born. Of the 59 infants studied, murmurs of AV valve regurgitation resolved over a 2 day to 6 month period. In three patients, AVVR, ventricular dyskinesia and ECG anomalies persisted for 2 months, 4 months and 48 months. Initial ECGs were abnormal in 57 patients and 60% returned to normal over a period of 6 days to 7 months (median 2 months)

ECG changes in birth asphyxia were studied in 25 asphyxiated new borns in the Dept. of paediatrics, Armed forces Medical College, Pune. According to the authors, ECG recording is a good parameter of diagnosis of ischemic damage of heart and it has a good correlation with myocardial histology and thallium imaging. Most of the ECG changes reverted to normal in 7-14 days.

Primhak et al²⁴ studied electrocardiogram and creatine kinase isoenzyme activities prospectively in 20 babies with thick meconium stained amniotic fluid and 43 normal neonates by adopting a previously described grading system for ischemic changes. A degree of electrocardiographic ischemic changes were defined which occurred solely in asphyxiated newborns. Infants with this degree of abnormality had significantly higher value of CK-MB and CK-MM activity at zero, eight and twenty eight hours. Histological changes of peripartum myocardial necrosis are seen in four of the five infants on whom autopsy was performed and either electrocardiogram or CK-MB isoenzyme activity was abnormal in all four. The study concluded that myocardial injury in the newborn period is often associated with CK-MB release, but caution is urged in the interpretation of elevated isoenzyme activity in the neonates.

According to Ranjit MS,² in Cardiac abnormalities in Birth Asphyxia, transient myocardial ischemia of the newborn should be suspected in all babies with asphyxia who are depressed at birth and having respiratory distress, and poorly felt peripheral pulses especially if a murmur is audible. According to Rowe's²³ classification, transient myocardial ischemia is classified into five types (Type A-E). Type B is a most severe form with respiratory distress cardiac failure and shock. ECG is very important for diagnosis of transient myocardial ischemia and may show abnormalities of waves ranging from T-wave inversion in one lead to classical segmental infarction pattern with abnormal q-waves. CK-MB isoenzyme is usually raised and found to be significant. Persistent hypoxia

sometimes result in persistence of constricted pulmonary vascular bed causing pulmonary arterial hypertension with consequent right to left shunting of blood across patent ductus arteriosus and foramen ovale. This causes respiratory distress and cyanosis.

Bancalari et al²⁵ investigated prospectively sixteen newborn infants of thick meconium stained amniotic fluid with severe asphyxia for evidence of secondary myocardial damage and in that case their clinical finding. Myocardial damage was diagnosed in this term newborn of adequate weight for gestational age (18.7%) by means of electrocardiogram, taken in the first seventy two hours of life. Two of them showed evidence of diffuse subendocardial ischemia and a third one showed electrocardiographic signs suggesting necrosis of the left ventricular posteroinferior wall. CK-MB levels correlate with the ECG and are useful in identifying the myocardial damage. All this affected newborns developed respiratory distress without signs of cardiac failure and one of them died. The histopathological study of this late one showed localized hemorrhages of the papillary muscles and interventricular septum. These findings stressed the importance of ECG recording and CK-MB estimation in babies with thick MSAF.

Moller et al²⁶ also observed similar results. They studied babies born with thick MSAF and depressed at birth by comparing with babies who are vigorous at birth. They measured CK and isoenzyme activity in the blood and found that CK and its isoenzyme CK-MB had been significantly elevated in the babies who had cardiac failure, and they concluded that CK-MB isoenzyme serve as an important marker for detection of myocardial damage.

AIMS AND OBJECTIVES

- To determine the levels of cardiac specific enzyme CK-MB in neonates with birth asphyxia
- To study the electrocardiographic and echocardiographic abnormalities in neonates with birth asphyxia
- To determine the outcome in affected patients based on a 3 months follow up.

MATERIALS AND METHODS

Study place	:	New born ward, Govt. Rajaji Hospital, Madurai.
Study Duration	:	March 2006 to September 2007 18 Months
Study Design	:	Prospective Observational study (Hospital based)
Study Population	:	Term newborns with birth asphyxia and normal term newborns as controls.

Selection of cases:

Inclusion criteria

Term new born babies with birth asphyxia

Exclusion criteria :

Preterm with birth asphyxia ,
New born with congenital heart diseases,
Narcotic administration to the mother.

The babies were considered asphyxiated if the baby had gasping or inadequate breathing or no breathing at 1 minute and if the Apgar score was 7 or less at one and five minutes of birth. The babies with asphyxia were staged according to Sarnat and Sarnat staging as HIE stage I, HIE stage II and HIE stage III . Of the 150 newborns studied, 50 were HIE stage I 50 were stage II, 25 were HIE stage III and 25 were normal newborns. Of these, 82 were male babies and 68 were female babies.

The details of maternal complications, maternal sedation, narcotics, details of the perinatal period, resuscitation details, birth weight, gestational age, Apgar score was recorded.

A thorough clinical examination was done. Blood sugar, urea, creatinine and electrolytes were sent. CK-MB levels were determined on day 1 between 6-24 hrs. The method used to measure CK-MB is by kinetic Immunoinhibition technique.

ECG was taken on Day 2 of life to avoid innocent repolarisation occurring even in normal new born on day 1. ECG was taken using BPL CARDIART 108 T, 220V, 50 Hz, 22VA machine and neonatal leads. 12 lead ECG was taken and photocopied with 100% magnification. According to the changes, they were classified into 4 grades proposed by Jedeikin et al

Grade I	:	Presence of flat or inverted T waves in one or two leads except aVR
Grade II	:	T waves flat or inverted in 3 or more leads except in aVR.

- Grade III : T waves flat or inverted in 3 or more leads and either ST segment depression or elevation more than 2 mm in atleast 2 chest leads or more than 1 mm in atleast two standard leads or q wave abnormality as defined by elevation of more than 0.02 secs or amplitude >25% of the r wave in one anterior or three related chest leads.
- Grade IV : Classical segmental infarction with abnormal q waves and markedly elevated ST segment or complete LBBB.

Echo cardiogram was done using B mode, M mode and colour Doppler using Aloka 2000 machine.

Echo was done on day 2 of life to detect valve regurgitation, right to left shunts, pulmonary hypertension and ejection fraction.

The cases were followed up.

Repeat CK-MB was done on Day 5, Repeat ECG and Echocardiogram were done after 3 months.

Statistical Tools

The information collected regarding all the selected cases were recorded in a Master Chart. Data analysis was done with the help of computer using Epidemiological Information Package (EPI 2002).

Using this software, frequencies, percentage, range, mean, standard deviation x^2 and 'p' values were calculated. A 'p' value less than 0.05 is taken to denote significant relationship.

OBSERVATION AND RESULTS

Table 1
Characteristics of cases selected for the study

Qualitative Variables		
Characteristics (HIE Staging)	Cases	
	No.	
%Normal	25	16.7
I	50	33.3
II	50	33.3
III	25	16.7
Total	150	100

- A total of 150 babies were included in the study.
- All were term babies with no congenital heart diseases
- Of the 150 babies studied 125 were asphyxiated babies (50 belonged to HIE-1, 50 belonged to HIE II, 25 were HIE III) and 25 normal babies (control)
- 82 were males babies and 68 were female babies.

Table 2**HIE Staging and CK-MB**

HIE Staging	CK-MB		
	Range	Mean	S.D.
Normal	7-31	14.56	5.92
I	28-184	59.4	31.43
II	58-291	142.16	47.81
III	175-512	261.68	103.99
'p' value between the four stages	0.0001 (significant)		
'p' value between			
a) Normal & I	0.0001 (significant)		
b) Normal & II	0.0001 (significant)		
c) Normal & III	0.0001 (significant)		
d) I & II	0.0001 (significant)		
e) I & III	0.0001 (significant)		
f) II & III	0.0001 (significant)		

- The CK-MB values in normal babies was between 7-31.
- CK-MB levels in HIE stage I was between 28-184
- CK-MB levels in HIE stage II was between 58-291
- CK-MB levels in HIE stage III was between 175-512
- There was a significant difference in the CK MB values between normal babies and asphyxiated babies (p 0.0001)
- Also, as the severity of birth asphyxia (HIE staging) increases the CK-MB values also increases significantly (p=0.0001).

Table 3
HIE Staging and T Wave changes

HIE Staging	T Wave changes					
	0		1		2	
	No.	%	No.	%	No.	%
Normal (25)	25	100	-	-	-	-
I (50)	46	92	4	8	-	-
II (50)	26	52	22	44	2	4
III (25)	2	8	18	72	5	20
Total (150)	99	66	44	29.3	7	4.7
'p' value between						
a) Normal & I	0.1895 (Not significant)					
b) Normal & II	0.0001 (Significant)					
c) Normal & III	0.0001 (Significant)					
d) I & II	0.0001 (Significant)					
e) I & III	0.0001 (Significant)					
f) II & III	0.0005 (Significant)					

Infants with perinatal asphyxia have transient myocardial ischemia

- No T wave changes were seen in control babies
- 4 newborns with HIE stage I had flat or inverted T waves in < 2 leads. None of the babies in HIE stage I had T wave changes in > 3 leads
- Of the 50 new borns HIE stage II, 22 had flat or inverted T waves in < 2 leads and 2 had T wave changes in > 3 leads
- Among 25 new borns with HIE stage III, 18 had flat or inverted T waves in < 3 leads and 5 had T wave changes in > 3 lead.
- T wave changes are significantly present in HIE stages II and III (p=0.0001)

Table 4
HIE Staging and ST changes

<i>HIE Staging</i>	ST changes			
	Absent		Present	
	No.	%	No.	%
Normal (25)	25	100	-	-
I (50)	50	100	-	-
II (50)	50	100	-	-
III (25)	24	96	1	4
Total (150)	149	99.3	1	0.7
'p' value between				
a) Normal & I	-			
b) Normal & II	-			
c) Normal & III	0.5 (Not significant)			
d) I & II	-			
e) I & III	0.333 (Not significant)			
f) II & III	0.333 (Not significant)			

- ST segment changes were not found in controls or in babies with HIE staging I and II
- One newborn with HIE stage III had ST depression in leads V1 and V2
- No significant correlation could be established between HIE staging and ST changes

Table 5
HIE Staging and Valve Regurgitation

HIE Staging	Valve regurgitation			
	Absent		Present	
	No.	%	No.	%
Normal (25)	25	100	-	-

I (50)	42	84	8	16
II (50)	30	60	20	40
III (25)	2	8	23	92
Total (150)	99	66	51	44
'p' value between a) Normal & I b) Normal & II c) Normal & III d) I & II e) I & III f) II & III	0.0318 (Significant) 0.0006(Significant) 0.0001(Significant) 0.0143(Significant) 0.0001(Significant) 0.0001(Significant)			

- Abnormally functioning but normal tricuspid valve is a common finding in the newborn with asphyxial cardiomyopathy.
- Tricuspid regurgitation was not found in control
- Tricuspid regurgitation was found in 8 (out of 50) HIE stage I new borns, 20 (out of 50) HIE stage II newborns, 23 (out of 25), HIE stage III new borns.
- Newborns with asphyxia have a greater incidence of tricuspid regurgitation compared with the control. (P= 0.0318, 0.0006, 0.0001)
- Also, as the severity of the asphyxia increases (ie. As the HIE staging increases), there is a significantly positive correlation with tricuspid regurgitation (P=0.0143, 0.0001, 0.0001)

Table 6
HIE Staging and PHT

<i>HIE Staging</i>	PHT			
	Absent		TR+	
	No.	%	No.	%
Normal (25)	25	100	-	-

I (50)	50	100	-	-
II (50)	48	96	2	4
III (25)	14	56	11	44
Total (150)	137	91.3	13	8.7
'p' value between g) Normal & I h) Normal & II i) Normal & III j) I & II k) I & III l) II & III	<p>-</p> <p>0.4414 (Not significant)</p> <p>0.0006 (Significant)</p> <p>0.2475 (Not significant)</p> <p>0.0001 (Significant)</p> <p>0.0001 (Significant)</p>			

- Persistent hypoxia results in persistence of constricted fetal pulmonary vascular bed causing pulmonary arterial hypertension
- Pulmonary hypertension was detected in 2 (out of 50) newborn with HIE stage II and 11 out of 25) new borns with HIE stage III.
- The relationship between pulmonary hypertension and HIE stage III as significant ($p=0.0006, 0.0001, 0.0001$).
- Qwave abnormalities, segmental infarction pattern in ECG changes were not found in any of the babies studied.
- Regional wall motion abnormalities and right to left shunts were also not present in any of the babies studied.

Table 7
HIE Staging and EF

<i>HIE Staging</i>	EF		
	Range	Mean	S.D.
Normal	64 - 74	67.48	2.52
I	61 - 85	67.14	4.06
II	59 - 73	66.3	2.82
III	50 - 67	59.25	4.05
'p' value between the four stages	0.0001 (significant)		
'p' value between			
1. Normal & I	0.0366 (Significant)		
2. Normal & II	0.0234 (significant)		
3. Normal & III	0.0001 (significant)		
4. I & II	0.0001 (significant)		
5. I & III	0.0001 (significant)		
6. II & III	0.0001 (significant)		

- Cardiac output is often diminished in birth asphyxia
- 12 control newborns, 16 (out of 50) HIE stage I newborns, 33 (out of 50) HIE stage II newborns and 24 (out of 25). HIE stage III newborns had decreased cardiac output (EF)

Table 8
T wave changes and CK-MB

T wave changes	CK-MB		
	Range	Mean	S.D.
0	28 – 192	76.2	39.3
1	80 – 402	190.9	61.1
2	253 - 512	368.7	100.1
‘p’	0.0001 (significant)		

- T wave changes were absent in 74 asphyxiated newborns.
- 44 newborns had T wave changes in < 3 leads
 - 7 newborns had T wave changes in > 3 leads
 - Comparing T wave changes with CK-MB a significance was found (p=0.0001).

Table 9
Valve regurgitation and CK-MB

Valve regurgitation	CK-MB		
	Range	Mean	S.D.
Absent	28 – 275	81.1	47
Present	28 - 512	208.2	95.9
‘p’	0.0001 (significant)		

- **Absent 74**
- **Present 51**
- Valve regurgitation (Tricuspid regurgitation) was found in 51 new borns and the CK-MB range in these babies was 28-512
- Comparing valve regurgitation with CK-MB, a significance was found (p=0.0001)

Table 10
PHT and CK-MB

PHT	CK-MB		
	Range	Mean	S.D.
Absent	28 – 275	109.4	59.6
Present	184 - 512	335.7	99.3
‘p’	0.0001 (significant)		

- PHT
- Absent 112
- Present 13
- Pulmonary hypertension was present in 13 newborns.
 - The relationship between pulmonary hypertension and CK-MB values was statistically significant. (p=0.0001).

Table 11
EF and CK-MB

Parameter	CK-MB		
	Range	Mean	S.D.
CK-MB	28-512	133	94.6
EF	50-85	66.1	5.1

- $p = 0.0001$
- **Correlation Coefficient between CK-MB and EF**
 $\text{'r'} = -0.7476$
- **These two were inversely correlated.**
- A statistically significant correlation exists between ejection fraction values and CK-MB levels ($p=0.0001$)
- Ejection fraction and CK-MB levels were inversely correlated ($r=-0.7476$).
 As the CK-MB levels increase, the ejection fraction decreases.

Table - 12
HIE staging and Outcome

HIE staging	No.of Deaths
Normal	0
I	0
II	2
III	14
Total	16

- 16 babies in the study died.
- Of those, 2 were HIE stage II newborns and 14 were HIE stage III.

Table 13
Outcome and CK-MB

Outcome	CK-MB		
	Range	Mean	S.D.
Normal	7 - 291	90.73	66.11
Death	178 - 512	301.63	111.02
p	0.0001 (significant)		

- The mean CK – MB values in newborns who died was 301.63
- The newborns who died had significantly higher CK-MB values compared with control (p=0.0001)

Table 14
Outcome and T Wave changes

Outcome	T Wave changes					
	0		1		2	
	No.	%	No.	%	No.	%
Normal (134)	99	73.9	34	25.4	1	0.7
Death (16)	-	-	10	62.5	6	37.5
p	0.0001 (Significant)					

- T wave changes were seen in 35 (out of 134) babies who survived.
- Among babies who died, all of them had T wave changes. (16 out of 16).
- A statistically significant correlation exists between T wave changes and death (p=0.0001)

Table 15
Outcome and ST changes

Outcome	ST			
	Absent		Present	
	No.	%	No.	%
Normal (134)	134	100	-	-
Death (16)	15	93.8	1	6.3
p	0.2013 (Not significant)			

- ST depression was found in only one patient
- A statistically significant relationship does not exist between ST changes and death.

Table 16
Outcome and Valve Regurgitation

Outcome	Valve Regurgitation			
	Absent		Present	
	No.	%	No.	%
Normal (134)	99	73.9	35	26.1
Death (16)	-	-	16	100
p	0.0001 (significant)			

- Valvular regurgitation was present in 26.1% of survivors and 100% of newborns who died.
- The relationship between death and valve regurgitation was significant (p=0.0001)

Table 17
Outcome and PHT

Outcome	PHT			
	Absent		Present	
	No.	%	No.	%
Normal (134)	132	98.5	2	1.5
Death (16)	5	31.3	11	68.8
p	0.0001 (significant)			

- Pulmonary hypertension was detected in 2 survivors and all 16 newborns who died
- A statistical significance ($p=0.0001$) exists between PHT and death

Table 18
Outcome and EF

Outcome	EF		
	Range	Mean	S.D.
Normal	58 – 85	67.38	3.71
Death	50 - 62	57.56	3.39
p	0.0001 (significant)		

- All 16 babies who died had low ejection fraction
- The relationship between death and ejection fraction is statistically significant (p=0.0001)

DISCUSSION

Transient myocardial ischemia is a complication in babies with birth asphyxia. This study was done to determine the effects of birth asphyxia on the cardiovascular system and also to find out if the effects on the cardiovascular system were transient or permanent. In this study, the parameters studied were CK-MB, T wave, ST changes, Q waves changes in ECG, valvular regurgitation, shunts, pulmonary hypertension and ejection fraction in Echo. This study was also an effort to establish a relationship between these parameters and the severity of asphyxia. The study also identified some of the factors associated with increased mortality.

Babies born with birth asphyxia showed a remarkable rise in CK-MB values. As the severity of birth asphyxia (HIE staging) increased, the CK MB values also increased. Barberi I et al¹⁰ in their study had found that severely asphyxiated newborn infants had markedly increased cardiac enzymes and these alterations were far less pronounced in neonates with mild asphyxia.

But Bhunia et al¹³ in autopsy conducted on asphyxiated neonates who died showed that the extent of damage though correlated with biochemical markers, did not correspond well with the extent of asphyxia and the survival period. Omokhodion²¹ et al in their study had found that asphyxiated negroid infants had significantly high mean CK and absolute CK-MB values.

CK-MB values were repeated on day 5 and the values returned to normal in all the survivors. CK-MB values are elevated at 4 to 6 hours after myocardial ischemia¹⁵. The levels return to normal after 72 hours. No studies on repeat CK-MB values were available.

ECG was taken to determine the ischemic changes in the heart of babies with birth asphyxia. It was found that significant changes occur in the newborns with moderate and severe birth asphyxia. A 12 lead ECG was recorded. Neonatal ECG reflects the hemodynamic relationships that existed in utero. Thus normal ECG is notable for right ventricular dominance. Throughout the neonatal period the ECG will evolve due to expected changes in physiology and the resulting changes in chamber size and thickness occur. When the ECG is abnormal, one should consider the abnormal placement of leads, which is simply done by comparing qrs complexes in limb lead I and precordial lead V6. Each should have similar morphology if the limb leads had been properly placed. Babies showed ECG changes according to the severity of asphyxia to which they are exposed.

T wave changes were measured in any chest lead or standard lead except aVr.

There should be flat or inverted changes. aVr was not included because T wave inversion in aVr is a normal phenomenon. Babies with HIE stage II and stage III had significant ECG changes. As the CK-MB values increased, the occurrence of T wave changes also increases. According to Farru o et al¹⁶ ECG changes of myocardial ischemia (ST and T wave changes) were present in 25 of the 30 asphyxiated babies studied.

ST segment measurement was done in chest leads or standard leads. ST segment elevation or depression of more than 2 mm in at least 2 chest leads and ST segment elevation or depression of more than 1 mm in at least 2 standard leads is considered as significant. ST wave form becomes elevated when myocardial oxygen delivery is insufficient to maintain aerobic metabolism to meet the energy demands of the myocardium and so anaerobic metabolism occurs with the production of lactate. ST segment depression was noted in only one new born with HIE stage III who also had T wave inversion but no q wave. ST elevation was not found in any of the babies studied.

Q wave abnormality indicates severe form of cardiac ischemic changes. It is abnormal if the wave exceeds 0.02 seconds or the amplitude of it measures more than 25% of the wave in one anterior chest lead or 3 related leads. No Q wave abnormalities were found in the babies studied probably because the sample size was small. Farru o et al¹⁶ in his study found that Q wave abnormalities were observed more rarely.

According to Ranjit MS² in cardiac abnormalities in birth asphyxia, the ECG changes range from T wave inversion in one lead to segmental infarction pattern with abnormal q waves.

The prognosis for surviving infants is good and the ECG changes revert to normal in three months according to Cloherty¹. Hence after 3 months, a repeat ECG was done in our study to confirm if the ECG changes reverted to normal. On follow up it was noted that the ECG changes were transient and were not seen after 3 months in our study also. According to Farru .O et al¹⁶ the ECG changes returned to normal in 15 days in 80% of the cases studied. So also, Gidvani et al,¹⁷ in their study find that in most cases, the changes return to normal within two weeks implying the great ability of the neonatal heart to withstand hypoxic insult. In contrast Turner Gomes et al¹¹ have noted that in 3 patients, ECG abnormalities persisted for 2 months, 4 months and 48 months.

Right ventricular myocardial disease causes tricuspid regurgitation. In our study, tricuspid regurgitation was not found in normal new borns. New borns with asphyxia had transient tricuspid regurgitation . As the HIE staging increased, there was an increase in the incidence of tricuspid regurgitation. According to Turner Gomes et al¹¹ atrio ventricular valve regurgitation was present in 23 out of 59 babies studied (39 percentage). In our study, tricuspid regurgitation was present in 44 percentage of the

asphyxiated babies.

As the HIE staging increased, there was an increased incidence of pulmonary hypertension. Babies with higher CK-MB values have increased risk of developing pulmonary hypertension. According to Ranjit MS,² persistent hypoxia sometimes results in persistence of constricted fetal pulmonary vascular bed causing pulmonary arterial hypertension with consequent right to left shunt across patent ductus arteriosus and foramen ovale. No right to left shunts are observed in our study though pulmonary hypertension was observed. No regional wall motion abnormalities were noted in this study.

Cardiac output is often diminished in birth asphyxia. Newborns with asphyxia have low ejection fraction (Normal ejection fraction in new borns = 68%)²⁰ As the CK-MB levels rise, the ejection fraction declines. According to Barberi et al,¹⁰ severely asphyxiated infants have depressed left ventricular function but the exact values of ejection fraction observed are not mentioned..

Among the babies studied, 134 survived. 16 babies died. In the study by Barberi et al,¹⁰ 5 out of 13 group 3 (severely asphyxiated) babies died.

COMPARISON WITH OTHER STUDIES

S. No.	Parameters	Out study	Ranjit MS et al ²	Barberi et al ⁹	Turner Gomes et al ¹⁰	Omakhodion et al ²¹
1.	CK-MB	Elevated	Elevated	Elevated	-	Elevated
2.	T wave changes	29.3%	Present	Present	Present	-
3	ST changes	0.7%	Present	Present	-	-
4	Q wave changes	-	Present	Present	-	-
5	Valve regurgitation	44%	Present	-	-	-
6	PHT	8.7%	Present	-	39%	-
7	Right to left shunt	-	Present	-	-	-
8.	EF	Reduced	Reduced	-	-	-

In comparison with other studies, CK-MB was elevated in our study and also in studies by Ranjit MS², Barberi et al⁹, Turner Gomes et al¹⁰ and Omokodion et al²¹.

In ECG, T wave changes were seen in 29.3%, ST changes in 0.7%, no Q waves were seen ; valve regurgitation was present in 44% in our study. In studies by Ranjit MS² T wave changes in one lead to a classical segmental infarction pattern were noted.

Turner Gomes¹⁰ et al also noted ECG changes of ischemia in asphyxiated newborns. Barberi et al⁹ noted ECG changes from Grade I to Grade IV.

In the present study, PHT was present in 8.7% and the Ejection fraction was reduced. Ranjit MS² also noted a reduced ejection fraction in asphyxiated babies.

Most surviving infants have normal cardiac findings in 3 weeks to three months¹. So, a repeat echo was done for the babies after three months. No residual effects were seen in them.

In our study, all the survivors show normal CK-MB values on Day 5, normal ECG and echocardiographic changes after 3 months. Tuner-Gomes et al¹¹ had found that although the cardiovascular sequelae of myocardial ischemia are usually transient, their data prompts the need for careful review after the initial insult.

Among the babies who died, CK-MB values were higher. All these babies had significant T wave changes. ST depression was seen in 1 patient who died.

Tricuspid regurgitation was present in all the babies who died. The frequency of pulmonary hypertension was more among the babies who died. All the babies who died had low ejection fraction.

In order to validate these findings and also to find out pathological changes in the myocardium in autopsy of the babies who died, further studies are necessary.

CONCLUSIONS

- ❖ Newborns with birth asphyxia had elevated CK-MB values.
- ❖ As the severity of birth asphyxia increased, CK-MB values also increased.
- ❖ As the HIE staging increased, there was an increased incidence of T wave changes in ECG.
- ❖ There was a significant relationship between tricuspid regurgitation and birth asphyxia.
- ❖ As the HIE staging increased, there was an increased incidence of tricuspid regurgitation.
- ❖ As the HIE staging increased, there was an increased incidence of pulmonary hypertension.
- ❖ Newborns with birth asphyxia had low ejection fraction.
- ❖ T Wave changes in ECG, Tricuspid regurgitation, pulmonary hypertension and low ejection fraction in echocardiogram were more frequently present in new borns with high CK-MB levels.
- ❖ 'Q' changes in ECG or right to left shunts due to pulmonary hypertension were not present in the new borns studied.
- ❖ Significant ST changes were not present in the study population.
- ❖ Survivors in this study showed no residual cardiac damage after three months.
- ❖ Among the babies who died, all had high CK-MB values, tricuspid regurgitation and low ejection fraction. Babies who died had significant T wave abnormalities and pulmonary hypertension.
- ❖ Further studies are necessary to validate these findings.

LIMITATIONS OF THE STUDY

- ❖ Autopsy was not done in the babies who died as the parents refused to give consent.
- ❖ Serial ECGs were not done in the study as the parents' compliance was poor.

RECOMMENDATIONS

- ❖ Effects of birth asphyxia are not limited to the central nervous system and hence damages to other organs have to be looked out for.
- ❖ Cardiac abnormalities in asphyxiated neonates are often underdiagnosed and hence a high index of suspicion and investigation for the same are required.
- ❖ CK-MB, ECG and Echo help in early recognition and hence better management of transient myocardial ischemia of the new born.

BIBLIOGRAPHY

- 1) John P.Cloherly, Eric C Eichenwald, Ann R.Stark : Manual of neonatal care. fifth edition. pg 536-554.
- 2) Ranjit M.S : Cardiac abnormalities in birth asphyxia Indian journal of padiatrics. 2000 March, 67(3suppl): s 26-29.
- 3) Post resuscitation management of an asphyxiated neonate, National Neonatology forum of India Teaching Aids – Newborn Care.
- 4) Finley JP, Giles Howman RZ :Transient myocardial ischemia of the newborn infant demonstrated by thallium myocardial imaging. Journal of paediatrics 1979;94:263-270
- 5) Daga SR : Myocardial ischemia following birth asphyxia, Indian Paediatrics. 1983: 567-571
- 6) Richert R, Behirschke K : Myocardial infarction in the perinatal period. Journal of paediatrics. 1959;55:706-712
- 7) Dische JR, Jimenez CL, Freedon RM, Rowe RD : Effects of perinatal hpoxia on the infantile heart (Abstract) American Paediatric Pathology. Club 1977.
- 8) Jedeikin R, Primahak A, Swyer PR, Rower RD (1998) Serial ECG changes in babies with thick MSAF Arch Dis child 58: 605-611.
- 9) Jedeiken R, Makala SK, Shennan AT, Rowe RD, Ellis G (1999): Creatine Kinase isoenzymes in serum from cord blood of babies with thick MSAF clinical chem. 28: 317 to 322.
- 10) Barberi I Calabro Mp, Cordaros, Gitto E, Sottile A, Prudente D, Berttucio G, Consolos : Myocardial ischemia in neonates with perinatal asphyxia. ECG, echocardiographic and enzymatic correlations. Eur J Paediatrics (1999): 158 (9): 742-7
- 11) Turner Gomes so, Izukawa T, Rowe RD, Persistence of atrioventricular value regurgitation and electrocardiographic abnormalities following transient myocardial ischemia of the new born- department of cardiology, University of Tornoto: Paediatric cardiology 10: 191-194.
- 12) Nelson RM, Etizman DV, Egan (1999): Serum CK-MB fraction in newborns with transient myocardial ischemia. England J Med 298:146
- 13) Meharban singh : Care of the New born. Sixth Edition : Pg 96-113.
- 14) Bhunia BC, Basu K, Batabyl SK, Khatwa SP, Sanyal S, Banerjee S, Basu A: Myocardial changes in neonates dying of asphyxia neonatorum (Abstract).
- 15) Kasper, Braunwald, Fauci, Hauser, Longo, Jameson, Harriosn's: Principles of Internal medicine. 16th edition : 1450-1451.
- 16) Farru O, Rizzardini M, Guzman N: Transient myocardial ischemia in

newborns (Abstract).

- 17) CH Gidwani : ECG changes in Asphyxia Neonatorum. Indian paediatrics. 1990: 1177-81
- 18) Soot H : Outcome of severe birth asphyxia. Arch Dis child 1976:51-712
- 19) Buccineraly E.L, Nelson RM, Egan II EA et al : Tricuspid insufficiency of the new born, a form of myocardial dysfunction in the stressed newborns. Indian paediatrics 1977, 59: 330-337
- 20) Kenneth et al : Text book of Paediatric cardiology. 471-488
- 21) Omokhodial SI, Losekoot TG, Jaiyesimi F : Transient myocardial ischemia in newborn babies with perinatal asphyxia. Dept, of Paediatrics, Ibadan, Nigeria.

- 22) Deorani AK Saxena, A. Singh, M.Shrivatsavas : Electrocardiographic assessment of infants born to diabetic mothers. Arch Dis Chil 1989: 64 :721
- 23) Rowe HD, Hoffman T (1999): Transient myocardial ischemia in newborn infant with asphyxia, Paediatric cardiology. Heart diseases of newborn. Vol 2: 1979 :87-107
- 24) Primhak RA, Jeideikin R, Ellis G et al (1999) : Myocardial ischemia in babies with thick MSAF. Acta paediatrics Scand 74: 595-600
- 25) Banclari A. Oliro C, Bello P, Sotto G, Pandol E, Leon L : Myocardial damage in babies with thick MSAF. Review Child paediatrics. 1999, 62(4): 232-7.
- 26) Moller JC, B Thielson, TF, Shaible, I Reiss, M Kohl, T Welp, L Gortner : Value of myocardial hypoxia markers and serum CK-MB for the retrospective diagnosis of asphyxia. Euro J. Paediatrics 2001, 58(4) : 757-762.

ABBREVIATIONS

ECG	Electrocardiogram
Echo	Echocardiogram
CK	Creatine Kinase
O ₂	Oxygen
BP	Blood Pressure
HIE	Hypoxic ischemic encephalopathy
IJP	Indian Journal of Paediatrics
AVVR	Atrioventricular valve regurgitation
EF	Ejection fraction
PHT	Pulmonary hypertension
LN	Labour naturale
HR	Heart rate
RR	Respiratory rate
TR	Tricuspid regurgitation
CK-MB	Creatine kinase – Muscle brain
TMI	Transient myocardial ischemia

LIST OF TABLES

- 1. Characteristics of selected for the study**
- 2. HIE staging and CK-MB**
- 3. HIE staging and T wave changes**
- 4. HIE staging and ST changes**
- 5. HIE staging and Valve regurgitation**
- 6. HIE staging and PHT**
- 7. HIE staging and EF**
- 8. T wave changes and CK-MB**
- 9. Valve regurgitation and CK-MB**
- 10. PHT and CK-MB**
- 11. EF and CK-MB**
- 12. HIE staging and outcome**
- 13. Outcome and CK-MB**
- 14. Outcome and T wave changes**
- 15. Outcome and ST changes**
- 16. Outcome and valve regurgitation**
- 17. Outcome and PHT**
- 18. Outcome and EF**

LIST OF FIGURES

- 1. BABY OF KALAIMANI - T WAVE INVERSION**
- 2. BABY OF BOWSIA – ST DEPRESSION**
- 3. BABYOF JEYARANI– TRICUSPID REGURGITATION**
- 4. BABY OF BOWSIA – PULMONARY HYPERTENSION**

BABY OF BOWSIA PULMONARY HYPERTENSION



BABY OF KALAIMANI

T WAVE INVERSION

